Can the production of cauliflower be increased during summer in Minnesota?

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Introduction

Cauliflower is a cool season crop, which usually only produces curds (the heads of florets) at 16-21°C. However, local markets have asked for cauliflower that is locally-grown during the summer when the average daytime temperature is above 25°C (Blythe, personal communication). Liptay (1981) found that 'Snow Crown' could form curds at 30-40ºC, so summer production is possible using this heat resistant, early variety. Vernalization (cold treatment) can also induce inflorescence development at 25°C. (Guo et al. 2004). Shading can be used to decrease growing temperatures, but it was not enough to induce 'Snow Crown' cauliflower to head in preliminary experiments in 2016. Hypotheses tested in this project to explain the lack of curd formation in 2016: (1) vernalization was inadequate to produce curds. (2) soil properties inhibited curd production, or (3) the shading treatment decreased photosynthetically active radiation at wavelengths necessary for flower induction.

Methods

- The experiment includes the following 3 treatments of cauliflower: vernalization, near infrared radiation-blocking Solar Ice plastic shading(to cool down the temperature for cauliflowers), and control in two locations (St. Paul and Waseca, MN) .
- Soil tests were done for both planting sites.
- Seeds were sown in May. After germination, the seedlings were transplanted into 6-inch pots.
- Plants were divided into plants at the 7-8 leaf stage and at 6 or fewer leaf stage. Plants at the 7-8 leaf stage were vernalized in the cooler at 10˚C under a 16-hour photoperiod for two weeks. Transplanting was done as shown in Table 1.
- Leaf surface temperatures were taken by infrared thermometer.
- Presence or absence of curd, curd diameter, and curd color were measured for each plant.
- Analysis of variance and Tukey's HSD were used to analyze the data. The model statements were Curd or Diameter or Color ~ treatment* Replicate*Row.

Table 1. Timeline of transplantation

Location	Days after sowing	Activities
St. Paul	31	Transplanted 80 plants:30 controls, 30 Solar Ice plastic low tunnels, and 20 for the border rows at the Cornercopia Student Organic Farm
St. Paul	70	Transplanted 21 organic vernalized plants
Waseca	36	Transplanted 112 plants: 36 controls, 36 Solar Ice plastic plants, and 40 border rows plants.
Waseca	51	30 vernalized plants were delivered to Waseca for transplantation the following day.

Results

The highest and the lowest values shown are means ± standard deviations.

Germination rates were similar for organic and conventional seeds (Table 2). However, only the control treatments in St. Paul produced curds , and not until late September.

In Waseca the curds from all treatments were harvested on August 31st. Analysis of variance showed that treatment did not affect curd development at Waseca (p=0.12). The average curd diameters for control, Solar Ice, and vernalized plants were 12.85 cm, 10.26 cm, and 15.68 cm, respectively. Mean curd diameter of vernalized and Solar Ice treated plants differed (p= 0.001), but were not different from the control plants. Curd color was also affected by the treatments . Control and Solar Ice curds differed in color (p= 0.02). Solar Ice curds were more yellow purple or cream than control curds, which were mostly white purple. (Figure 1). Vernalized curds were mostly white purple and yellow purple. Temperatures on August 31 were significantly higher under Solar Ice than for control or vernalized treatments, which were uncovered (Table 3).

Table 2. Germination rates for organic and conventional seeds.

Type of seeds	No. of seeds sown	No. of germinated seeds	Germination rate
Organic seeds	121	106	0.88
Conventional seeds	120	102	0.85
Organic seeds	110	37	0.34
Conventional seeds	200	69	0.345

*Germination rate = (Number of germinated seeds)/ (Number of seeds sown)

Figure 1. Representative curd colors observed in Waseca-grown cauliflower

White and firm (Ideal curd) | Yellow and firm | Cream and firm | Purple yellow and loose | Cream and totally loose

Table 3. Cauliflower plant temperatures under the different treatments at Waseca.

Treatment	Average temperature ± standard deviation (°C)	Highest temperature (°C)	Lowest temperature (°C)
Control	20.4 ± 1.6	21.9	18.8
Vernalization	19.2 ± 0.8	19.97	18.4
Solar Ice	25 ± 2.6	27.6	22.4

The highest and the lowest values shown are means ± standard deviations.

Discussion

The fertilizer applications, seed sources and production management were different in St. Paul and Waseca, so the experiment was not truly replicated at the two locations. Soil tests results showed that both sites had adequate levels of nitrogen, phosphorus, and organic matter (data not shown), so soil effects were probably not a factor in lack of curd production in 2017 in St. Paul. Severe aphid infestations of the organic cauliflower may have stressed those plants enough to delay curd production. A different site at Waseca was used in 2017 than in 2016, and soil tests were not done in 2016, so conclusions about soil effects cannot be drawn.

Based on temperature data, the low tunnel with Solar Ice plastic did not lower plant temperatures compared to the controls. Plants grown under Solar Ice plastic produced curds in the summer at Waseca, but their leaves turned yellow. A possible reason for the failure to decrease the temperature could be not enough air flow, trapping heat in the low tunnels. Also, since the controls produced curds in summer, the 'Snow Crown' cauliflowers may not need vernalization treatment to produce curds. However, the vernalized plants produced curds earlier than the controls in Waseca. The colors (with purple indicating stress) and the size of the cauliflower curds were also affected by the treatments.

References

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